4.2 Importance and uses of biodiversity in India

4.2.1 Ecosystem services and values of biodiversity

There is growing public awareness about the importance of maintaining a high level of biodiversity in the context of what is referred to as "ecosystem services".

It is important at the outset to make a distinction between biodiversity and biological resources and between natural ecosystem, diverse agro-biodiversity and homogenised agro-systems. The presence of eucalyptus or rauwolfia in a garden or hybrid rice in a field may not carry a biodiversity value although these species undoubtedly are valueable biological resources because of their usefulness.

Biodiversity values are very evident in a natural ecosystem because in such a system, the presence of diverse species and taxa, plant, animal, microorganism, is not due to chance or engineered by some external designer but is as a result of intrinsic ecological and evolutionary processes guided by edaphic, symbiotic, synergistic, genetic, antagonistic and several other insufficiently understood principles of conservation science and the value of the system is evident in its ecology. It is however less clear how biodiversity values could be assessed in a diversed agricultural system which is a product of human intervention with a natural ecosystem. One could discern the biodiversity values in such a system design, if it has demonstrated ecological stability over a sufficiently long period of time and also met with the social, cultural and spiritual needs of the communities that depend on it. The credit for design of such integrated system must be given to native farmer-ecologists of yore, and to their current counterpart for initiating, evolving, adapting and sustaining the system over generations and successfully transmitting essential information about their design principles to their succesors.

Ecosystem services are in a sense the myraid fruits arising out of normal functioning of a natural ecosystem. They are all the services generated as a result of interaction and exchange between biotic and abiotic components of ecosystems. The ecosystem services include numerous invisible but essential services, viz., soil formation and fertility generation, reduction of soil salinity, decomposition and waste dissipation, productivity, carbon sequestration and atmospheric gases balance, stabilization of climate and mitigation of climatic change, nutrient cycling, maintenance and raising of water table, water and air filtration, flood and drought control, etc.

From the way we manage the forest and river systems to the way we deal with the coastal and agro-diversity, there is serious neglect of ecosystems and consequently of their potential services due to ignorance of the value of the ecosystem design. Eutrophication of the lakes of Kashmir, Nainital and other such water bodies and loss of their hydrological and ecological value, receding glaciers and depleted water flow to rivers, increase in the intensity of flood peaks, landslide and erosion in mountains, widespread gulley formation in Chambal ravines, fragmentation of forests and reduction of forest cover to less than 12% of the total land mass, conversion of diverse oak forests into pine forests in Himalaya, poor regeneration of sal in shivaliks, degradation of mangroves wherein 26- 46 % of the area under mangroves is estimated to have been lost (Green India 2047, TERI 1998), destruction of coral reefs and coastal life, salinisation and depletion of groundwater (number of ground water blocks under stress increased from 253 in 1984-85 to 422 in 1992-93, (Green India 2047, TERI 1998), metal toxicity in water, widespread expansion of exotic invasive species in natural

ecosystems both terrestrial and aquatic, shortage of drinking water, spread of water borne diseases, High levels of pollution in Indian rivers specially the smaller ones and even the bigger ones like the Ganga and Yamuna, Sabarmati, Indus, Godavari, Periyar, Nagyal, Bhavani and Damodar, (State of India's Environment, CSE 1999), degradation of recharge zones and drying-up of springs, almost complete extermination of vulture and lion, spread of slums, prolonged duration of winter fog, severe air pollution, loss of breeding habitats of turtles, conversion of swamps and other wetlands into agricultural land, shortening of rotation in shifting agriculture and consequent depletion of soil and fertility, are some of the examples to indicate how impacted are our ecosystems and flow of their services.

A balanced approach to bio-diversity should be based on the understanding that people of every region depend on the daily flow of local ecosystem services for managing their living, therefore there is a need to value and conserve the natural ecosystems of all regions and not only focus on hot-spots or flag-ship species. Identification and recognition of ecosystem services is therefore required at various scales from local to regional, national and global levels. Unfortunately, almost nothing has been done in India in regard to developing conservation approaches that have evaluated & considered ecosystem services in an integrated and systematic way.

Comparison of the ecosystem services of three Himalayan forests

Forest	Ecosystem characters	Ecosystem services
Banj oak (*Quercus leucotrichophora*)	Large biomass (400-500 t ha^{-1}); deep roots and deep carbon storage in soil; high amount of investment of photosynthesis in ectomycorrhizae, massive annual return of nutrients to soil.	Rapid soil formation, high soil fertility, effective carbon sequestration; effective nutrient and water retention.
Chir pine (*Pinus roxburghii*)	Small biomass (200-250 t ha^{-1}); high productivity on degraded slopes, high nutrient use efficiency; high stress tolerance, effective coloniser, more fire proness, depletion of flow in water springs.	Supply of ecosystem services in inhospitable conditions; retention of nutrients on steep and rocky slopes; moderate nitrogen enrichment
Alder (*Alnus nepalensis*)	Very small biomass (<100-150 t ha^{-1}), very high productivity (up to 30 t ha^{-1} yr^{-1}); rapid coloniser of fresh landslip; very high rate of N-fixation (up to 200 kg N ha^{-1} yr^{-1}).	Facilitation of more useful species, high carbon fixation, nutrient supply to other ecosystems.
Lantana camara (an invasive species)	Very small biomass (<30 t ha^{-1}), productivity similar to oak and pine; carbon shortage in shallow soils, low biodiversity, cool but frequent fires.	Low soil carbon storage, persistent fire regime, low nutrient and water retention.

Source : SP Singh, Ecosystem services, 2001

Mountain Forest Ecosystem and Water

Mountains and their forest ecosystem are regarded as the water towers of the world. The extraordinarily massive Himalayan Mountains for example have shaped the climate of the Indian subcontinent and provided water and soil to the Gangetic plains. Among the contribution of Himalaya are the monsoon pattern of rain, high round the year humidity, mild winters and slow lapse rate of temperature with increasing altitude.

The ecosystem services of the Western Himalayan forests to the people in the Gangetic plains are listed as following:

1. Maintaining water flow in rivers and lakes which contributes to pollution control and helps maintain aquatic diversity and soil and water storage.
2. Controlling flood peaks and erosion.
3. Rapid soil formation, particularly in oak forests, thus nursing crop-fields both in hills and plains by providing soil and nutrients.
4. Carbon sequestration and climate stabilization.
5. Restoration of landslide sites through the process of succession in which N_2 fixer woody species like alder (*Alnus nepalensis*) and coriaria (a bush) play important facilitating role. *In fact, succession is a composite ecosystem service generating soil, nutrients and control over all destabilising physical forces of nature.*

Source : SP Singh, Ecosystem services, 2001

4.2.2 Livelihoods

Particularly in a largely tropical country like India with a range of terrestrial and aquatic landscapes biodiversity supports livelihoods of millions of eco-system people. Around 70 % of the Indian population depends on land based occupations, forests, wetlands and marine habitats and is thus dependent on the local ecosystems for their basic subsistence requirements with regard to water, food, fuel, housing, fodder and medicine. Around 10,000 species of plants, a few hundred of fish and animal species are involved in this direct relationship of biodiversity and livelihood.

Apart from this livelihood dependency for subsistence needs, there is livelihood dependency for seasonal or annual income derived from on a wide range of terrestrial and aquatic wild resources. There are estimated to be around 20 million mandays per year involved in medicinal herb collection from the wild for a collection valued at around 112 crores per year (FRLHT, 2001).

275 million people in India depend upon on non-timber forest products(NTFP) for their livelihood (Bajaj, 2001). NTFP collection generates about 1063 million human-days of employment in India (Khare, 1989) and about 60- 70% of NTFP gatherers are women (Gera, 2001) .

The table below gives the picture of livelihood dependents on wild plants which occur in common property resources. It is significant that the highest livelihood dependence on CPRs is that of the rural poor.

Table 1: Livelihood Linkages with Common Property Resources

	Gini coefficient on

No. of Districts and villages by state	Household By income Categories[b]	Fuel[c] (%)	Animal grazing	Employment[e] Days	Annual income[f] (Rs)	% income From CPRs	income from[g] All sources	All sources except CPRs(%)
Andhra	Poor	84	-	139	534	17	0.41	0.50
Pradesh (1,2)	Others	13	-	35	62	1	0.41	0.50
Gujarat (2.4)	Poor	66	82	196	774	18	0.33	0.45
	Others	8	14	80	185	1	0.33	0.45
Karnataka	Poor	-	83	185	649	20	-	-
(1,2)	Others	-	29	34	170	3	-	-
Madhya	Poor	74	79	183	733	22	0.34	0.44
Pradesh (2,4)	Others	32	34	52	386	2	0.34	0.44
Maharashtra	Poor	75	69	128	557	14	0.40	0.48
(3,6)	Others	12	27	43	177	1	0.40	0.48
Rajasthan	Poor	71	84	165	770	23	-	-
(2,4)	Others	23	38	61	413	2	-	-
Tamil Nadu	Poor	-	-	137	738	22	-	-
(1,2)	Others	-	-	31	164	2	-	-

Source: Jodha 1986

a. CPRs include community pasture, village forests, waste land, watershed drainage, river and stream banks, and other common lands. Data indicate average area per village.

b. The number of sample households from each village varied from 20 to 36 in different districts. "Poor" house-
Holds are defined as agricultural laborers and small farmers (< 2 ha dry land equivalent). "Others" includes large
Farm households only.

c. Fuel gathered from CPRs as proportion of total fuel used during three seasons covering the whole year.

d. Grazing days per animal unit on CPRs as a percentage of total grazing days per animal unit.

e. Total employment from CPR product collection.

f. Income derived mainly from CPR product collection. The estimation procedure underestimated the actual Income derived form CPRs.

g. A higher Gini coefficient indicates a higher degree of income inequalities. Calculations are based on income
Data for 1983-84 from a panel of households covered under ICRISAT's village level studies
The panel of 40 households from each village included 10 households from each of the categories,
Namely large, medium, and small farm households and laborer households.

There are estimated to be 22 million fisher-folk who depend on aquatic habitats for their livelihood (Kocherry, 2001).

Over 200 castes are engaged in pastoral nomadism and they constitute as much as 6 % of the total Indian population (CSE, 1982 page 118)

The small and marginal farmers who account for over 80% of the farming community in India are directly dependent on agro-biodiversity for their livelihood.

The extent of livelihood dependency on biological resources and their host ecosystems is thus very substantial and there is an enormous challenge in a BSAP to suggest ways to make this dependence sustainable.

It would be wholly unjust to alienate the so called ecosystem people from their traditionally used resources is not available. Eco-system specific solutions, therefore, need to be found to match the imperatives of ecological sustainability with livelihood security.

4.2.3 Health and Food Security values

It is a curious fact but empirical evidence reveals that the largest use by communities of eco-system resources, (8000 species of plants and a few hundred species of animals) is for maintaining "health security" of human, livestock and plants(bio-pesticides and bio-fertilizers).

Medicinal Plants Species Diversity & Representative Species of Biogeographic zones of India

Sr. No	Biogeographic region	Estimated number of medicinal plants	Examples of some typical medicinal species
1	Trans Himalayan	700	*Ephedra gerardiana* Wall., *Hippophae rhamnoides* L., *Arnebia euchroma* (Royle) John

2	Himalayan	2500	*Aconitum heterophyllum* Wall. Ex Royle, *Ferula jaeschkeana* Vatke and *Saussurea costus* (Balc.) Lipsd. *Nardostachys grandiflora* DC., *Taxus wallichiana* Zucc., *Rhododendron anthopogon* D.Don and *Panax pseudoginseng* Wall.
3	Desert	500	*Convolvulus microphyllus* Seib ex Spreng (Syn *C. pluricaulis* Chois), *Tecomella undulata* (Sm.) Seem, *Citrullus colocynthis* (L.) Schrader and *Cressa cretica* L.
4	Semi-Arid	1,000	*Commiphora wightii* (A.) Bhandari, *Caesalpinia bonduc* (L.) Roxb., *Balanites aegyptiaca* (L.) Delile *and Tribulus rajasthanensis* Bhandari & Sharma.
5	Western Ghats	2000	*Myristica malabarica* Lam., *Garcinia indica* (Dup.) Choisy, *Utleria salicifolia* Bedd. and *Vateria indica* L.
6	Deccan Peninsula	3000	*Pterocarpus santalinus* L.f., *Decalepis hamiltonii* Wight & Arn., *Terminalia pallida* Brandis and *Shorea tumbuggaia* Roxb. *Pterocarpus santalinus* L.f
7	Gangetic Plain	1000	*Holarrhena pubescens* (Buch-Ham.) Wallich ex DC., *Mallotus philippensis* (Lam.) Muell.-Arg., *Pluchea lanceolata* C. B.Clarke and *Peganum harmala* L.
8	North-East India	2000	*Aquilaria malaccensis* Lam., *Smilax glabra* Roxb., *Ambroma augusta* (L.) L.f. and *Hydnocarpus kurzii* (King) Warb.
9	Islands	1000	*Calophyllum inophyllum* L., *Adenanthera pavonina* L., *Barringtonia asiatica* (L.) Kurz and *Aisandra butyracea* (Roxb.) Baehni.
10	Coasts	500	*Rhizophora mucronata* Lam., *Acanthus ilicifolius* L., *Avicennia marina* Vierh and *Sonneratia caseolaris* (L.) Engl.

Source: D.K. Ved, FRLHT, 2001

The species used in health-care include a vast diversity of eco-system specific food and fodder plants including species that are used by communities in times of scarcity.

With the development of modern high yielding varieties of crops and growing homogenization of food habits across the world an increasing reliance in market linked towns and cities has been placed on a few edible species. This was not always the case, nor is it still in many rural parts of the world. Approximately 80,000 edible plants have been used at one time or another in human history of which at least 3,000 have been used

somewhat consistently (Ayensu 1983:22). However only about 150 have ever been cultivated on a large scale and a mere 10 to 20 provide 80 to 90% of the world's calories today(Soule, Carre and Jackson 1990)

A considerable part of daily food intake of rural (especially tribal) communities comes from the wild. In an extensive study of wild foods by Singh and Arora(1978), information was collected from all over the country which revealed that a wide variety of tubers, edible grasses, flowers, fruits and seeds are eaten. Some examples are cited below:

Edible greens include leaves of Ardisa species and *Haliosma pinnata* from the north east; *Eremurus himalaicus* sedum species, *origanum vulgare, arenaria holosteoides & urtica hyperborean* in Lahaul and Ladakh, in coastal areas, *Sesuvium portulacastrum* is eaten as spinach. Examples of edible seeds include those of *Nyphaea* and *Nelumbo* species, *Buchanania lanzen, Euryale ferox, Cleome icosandra* and *Alpinia galanga.*

Tribal populations in Madhya Pradesh, Andhra Pradesh and Santhal parganas of West Bengal (central and eastern India) use lichen species such as *Heterodermia tremulans. Everniastrum cirrhatum, Parmorrena reticulatum, P. ticnctorum, Ramalina subcomplanata.. Usnes longissies, Rocella montagnei* as spice and flavouring agents (Singh & Sinha 1993.). In coastal areas of the southern state of Tamil Nadu, seaweeds such as Gracilaria edulis are used for making gruel (Chennubhotia et.al., 1993).

Some examples of floral species utilized primarily as famine foods, in Sikkim are the flowers of Urtica dioca and U. parviflora, rhizomes of Dioscorea species, fruits of *Aesandra butyracea, Calamus erectus, Eleagnus conferta, Heracleum lanatum, Podophyllum hexandrum, Machillus edulis, Melia dubia, Monus australis, Terminalia chebula, Zanthoxylum acanthopodium,* shots of Rheum nobile, Diplazium esculentum, Polygonum molle, Ficus vireus etc., Similarly, in the Rajasthan desert, famine foods include *Prosopis cineraria, Cenchrus biflorus,setigerus, Calligonus polygonoiges, Citrullus cologcynthis, s. lanatus. Dactyloctenium aegyptium, Acacia jacquemontii, A. leucophloes, Aizyphus nummularia, z. Mauritania, Indigofera cordifolia, Tamarindus indica, Capparis decidus, Salvadora oleoides, Achranthes aspera, Eleusine coracana,*

sesamum indicum and Cyperus rotundus. It is also interesting that the desert locust (Schistocera gregaria) is relished both fresh and preserved and used during periods of scarcity. In the Bhimashankar wildlife sanctuary in Maharashtra , dried unripe fruits of *Bombax ceiba* are stored and eaten during food shortages; unripe and ripe fruit of *Jasmimum malabaricum* is also boiled, dried and stored as cereal for times of food scarcity. It appears that earlier each household would store 5-6 kgs of this species for periods of shortages(Borges & Rane 1992). The Padhars of Gujarat in western India dig tubers of *Scirpus kysoor* in times of famine (AICRPE 1989: 16). Grain amaranths were similarly used as reserve foods in the Himalayas (Joshi & Rana 1991).
Wild edible seeds were also used as famine foods. Examples are Indigogera glandulosa, I. Linifolia, and I. Cordifolia, out of whose flour bread was baked. Seeds of grasses such as Echinochloa, Panicum, Eleusine species were made into bread or roasted. Grains of Bambusa were cooked as rice. Grains of legumes – Vigna capensis, Phaseolus sublobatus were cooked as pulses (Singh & Arora 1978).

Several plant species are used for their insecticidal properties: Ipomea species are used against aphids and larvae of insect pests; Fagonia indica var. schweinfurthii for insects like blister beetle in bajra crop; castor for termite aphid; Calotropis gigantean for aphids; Leucas inticafolia and chillie for pests of storage; Euphorbia species for larvae and pigeonpea; *Clerodendron multflorum* for aphids; Eleusine coracana for termites; Bidens biternata for insect pests of paddy (Gupta et al., n.d: Annexure 1). Recently, much emphasis is being placed on neem (Azadirachta indica) as a biopesticide. M. Krishnan has given an account of how jowar grains were stored for more than 30 years by being sealed in between layers of neem leaves in bins and buried in a 12 ft. deep pit (The Statesman, 22.3.92) Storing of wheat and barley grains with cowdung ashes was a practice to prevent insect attacks (Atkinson, 1973(1882). Besides the leaves, seeds and the oil from the seeds are used also as pesticides (Dastur, 1964: 30). The crushed fruit of Catunaregam spinosa ssp.spinosa is used to protect stored grains; the oil cake of Madhuca longifolia and the oil and leaves of Deris indica(=Pongamia pinnata) are used for their insecticidal properties (Dastur, 1964). Apart from neem, the oil from the seed of marking nut (bibba) is smeared and mixed with grain and is believed to be the most effective

protection from insects and pests. This is a practice in the Marathwada region of Maharashtra, where the tree is native (Darshan Shankar, pers. Comm.)

4.2.4 Economic values

The economic value of eco-system services and components of bio-diversity, as estimated by constanza etal(1997) amounts to US $ 33 million, which is around 1.8 times more than the world's GNP. Whereas these estimated give an overarching macro picture of the economic value of bio-diversity, it should be possible to disaggregate the overall economic values and form estimates of the economic worth of biodiversity in the context of specific industries and sectors. However, serious research in this field has only been recently initiated and the methodologies for valuation are still being evolved. Therefore there is sketchy information on the economic values of bio-diversity. The inadequacy of economic data only reflects the limited efforts put into generating the data but this need not raise any doubt about the immense economic values of bio-diversity. Examples of the economic valuation of some biodiversity components is given below by way of illustration.

Box 1: **Values in Agriculture, Livestock and Fisheries**

The contribution of natural and modified biodiversity in terms of crops, livestock, and fisheries, is very substantial, and at least a part of this is expressed in commercial terms. Livestock also contributes significantly to India's economy. Cattle and buffalo are estimated to contribute nearly 15% of gross national income. The all-India value of goats (products such as meat, skin and hair) is calculated at about Rs. 13396 lakhs (1,339.6 million). The total annual value of poultry production is estimated to be Rs. 17550 lakhs (1,755 million), while pork and pork products contribute more than Rs. 150 million to the economy (PID, 1990). The gross value of output from Animal Husbandry and Dairy Development sectors is estimated at Rs. 44,500 crore (445,000 million) in 1990-91 (Ministry of Finance,1992-93: 167).

In India, most fish spawn comes from the wild with less than 10% of fish spawn being produced artificially (Prescott-Allen & Prescott-Allen, 1982). However, the fisheries' sector is one which has noted much progress in monetary terms. Exports of marine products in 1992-92 are estimated at Rs. 1375 crore (Ministry of Finance 1992-93: 168). The most favoured species of India's sea catch are sardines (especially oil sardine), Indian mackarel and prawns (Jhingran, 1991: 585).

Box2: Value of Marine Bioresouces

Chemicals like prostaglandins, medically useful for birth control, prevention of peptic ulcer, asthama treatment, blood pressure regulation, etc., are obtained from marine species like gorgonids (Thomas & George, 1993). Biomedical properties are also present in sponges - the compounds Aerothionin and Aeraphysinin, halogen compounds like bromine and iodine; spongouroidine and spongothymidine have antitumour and antiviral activities respectively (Thomas 1993). The blue-coloured blood of the horseshoe crab contains a chemical called "amoebocyte lysate" which is used to test the magnitude of adulteration of food and medicines (Indian Express, 22.4.92; Probe India, May, 1992).

Box3: Values of Micororganisms

Microorganisms (fungi, actinomycetes and bacteria) are used to transform chemically synthesized steroid hormones in such a way so as to make them resemble naturally occurring hormones. These can be used clinically. Thus, antibiotics formed by fungi are penicillins from Penicillum species; Cephalosporins from Cephalosporium species; Griseofulvin from P. griseofulvum. Unicellular bacteria such as Bacillus brevis, B. polymyxa, B. subtilis produce the antibiotics Gramicidine, olymyxin B and Bacitracin respectively. Antibiotics formed by actinomycetes are Chloramphenicol from Streptomyces venezuelae, Tetracyclines from S. rimosus and S. aureofaciens; Neomycin from S. fruidiae, Erythromycin from S. erythreus, Nystatin from S. noursei and Amphotericin B from S. nodusus. (Guru, 1990: 73-74).

Box 4: Values of Wild Medicinal Plants

The pharmaceutical industry still depends to a great extent on wild resources estimated at around 1200 million rupees/year. Around 660 wild species are involved in all-India trade. (FRLHT, Trade database, 2001)

Table 2: Economic value of the components of Natural Resources: Some Select Indian Studies

Goods and services valued	Annual Value	Location	Methodology applied	Source
Recreation/ Ecotourism	Rs.16197 per ha. (Rs.427.04 per Indian visitor Rs.432.04 per foreign visitor)	Keoladeo National Park, Bharatpur	Travel Cost Method	Chopra (1998)
Recreation/E cotourism	Rs.20944 per ha. (Rs.519 per Indian visitor and Rs.495 per foreign visitor)	Keoladeo National Park	Contingent Valuation Method	Murthy& Menkhuas (1994)

Recreation/Ecotourism & other benefits	Rs.23300 per ha. (Rs.90 per household. (Rs.7.5/month/household);Rs.240 Million/year	Boriveli National Park, Mumbai	Contingent Valuation Method	Hadker et.al (1995)
Ecotourism	Rs.676 per ha . (for locals); (Rs3.2 million total per year)	Periyar Tiger Reserve	Contingent Valuation Method, Travel cost Method	Manoharan(1996)
Ecotourism	Rs 2.95 million total; (Rs.34.68 per visitor)	Kalakadu Mundanthurai Tiger Reserve, Tamil Nadu	Contingent Valuation Method	Manoharan and Dutt (1999)
Ecotourism/recreational/pilgrimage/sacred grove	WTP for maintenance and preservation of the lake by: Local community= US $ 0.88 (Rs.36.08) Local pilgrims = US$ 2.2 (Rs90.2) Resident visitors=US$ 2.5 (Rs102.5) Non-resident visitors=US$7.2 (Rs.295.2) (Aggregate WTP = US $46940 based on total visits per year (Rs1.92 million) Per hectare value = Rs.1604	Recreational value of a sacred lake in Sikkim Himalaya (Khecheopalri lake)	TCM & CVM	Maharana et.al.(2000)
Ecotourism	WTP for the management of the park: By foreign tourists: $8.84; by domestic tourists:$1.91; by local community:$6.20 per year. WTP total for annual maintenance works out to $87,777.	Khangchendzonga National Park, Sikkim	CVM	Maharana et al. 2000
Wetland	Additional value of property around the lake is Rs. 186 per sq. ft.	Bhoj Lake, Bhopal	Hedonic pricing	Madhu Verma (2000)
Soil conservation	Cost of soil erosion: Rs.21583 per hectare	Doon valley	Replacement cost approach	Kumar, P. (2000)
Soil conservation	Decline in Value of land due to soil degradation is Rs.3510 per hectare.	Haryana agricultural land	Productivity approach	Kirit Parikh (2001)
Urban water pollution	Av. Cost of illness per household per year: Rs. 1094	City of New Delhi	Production function	Dasgupta, P. (2001)
Biomass/dung/watershed	Value of additional dung collected due to stall feeding is Rs.34.40 per cattle per year	Sukhomajri village	Opportunity cost	Chopra et al., 1990

Water supply	Rs.4745 per hectare	Almora Forests	Indirect Methods	Chaturvedi, 1993
Water supply	Annual willingness to pay for water: Rs. 109-410 for irrigation purposes; Rs.27-53 for drinking purposes	From glacier to Tarai mountain region of Kumaon valley	Contingent valuation method	Kadekodi, 2000
Ecological functions (use value) for local residents.	Rs.624 per hectare	Yamuna Basin	Contingent Valuation method	Chopra and Kadekodi, 1997
Carbon store	Rs. 1,292 billion for total Indian forests) & Rs.20125 per hectare	Indian Forests	Species wise forest inventory data	Haripriya (1999)
Carbon Store	Rs.1.2 lakh per hectare	All India forests	Biomass estimation	Kadekodi & Ravindranath (1997)
Urban Air pollution	Statistical value of life affected:Rs.2.87 lakhs per life; Human capital value affected: Rs. 3.83 per life	Mumbai city	Dose – response model	Jyoti Parikh (2000)
Water pollution	WTP for best quality: Rs. 500; for 1995 quality: Rs. 200; for 1985 quality; Rs. 100 (all these are median values)	River Ganga	CVM for non-user benefits	James and Murty, 1999
Water pollution	Economic cost of pollution abatement per kilo-litre wastewater per day in tanneries: Rs.20-66	Tanneries in Tamil Nadu	Cost-benefit model	U. Sankar (2000)
Fishery resources	Willingness to pay for conservation: Rs. 859 per year on average	Coastal Karnataka	Stakeholder Analysis and CVM	Bhatta (2000)
Watershed Values (Soil conservation)	Rs.2.0 lakh per hectare meter of soil	Yamuna Basin	Indirect method (Reduced cost of alternate technology)	Chopra & Kadekodi,1997
Forests in Himachal Pradesh	*The total economic value of forests in HP is estimated as Rs.106664 Crores, which is 2.61 times the value of the growing stock. * The contribution of forestry as a percentage of corrected GSDP is 92.40% instead of recorded 5.26%.	Himachal Pradesh State	TEV approach	Verma (2000)
Forests in	*Contribution of forests is estimated	Maharashtra	Physical	Parikh and

Maharashtra	as Rs.35,245.65 millions as against Rs.14,080 millions shown in SNA. (i.e. it is 3.56 % of adjusted NSDP and not 1.46 % recorded) *Value of depletion (difference between the value of opening stock, other volume changes and the closing stock in forest accounts) = Rs.6.989 millions. (this is 19.8 % of the estimated value added) *Estimated asset values of forests = 28.6% of net fixed capital stock.	state	accounting (tools employed: net price method, present value method, etc)	Haripriya (1998)
Forests in Yamuna Basin	*Use Value of timber: Rs.8,279 to Rs.18,540 per cubic meter of extracted timber *Annual Value of main non-timber forest products (NTFPs): Rs.7509 per sq. km in Hills and Rs.558 per sq. km in Plains *Use value of ecological functions and unrecorded production: Rs.176 per hectare in Himachal Pradesh Rs.3509 per hectare in Haryana Average: Rs.624 per hectare *Value of preservation as contributing to national output: Rs.576lakhs per year *Household willingness to pay in rural areas for use value of forests: Rajasthan: Rs.1072 per hectare Uttar Pradesh: Rs.360 per hectare Himachal Pradesh: Rs.176 per hectare Haryana: Rs.3509 per hectare	Yamuna Basin	CVM Direct market valuation Multi-criteria analysis & Travel cost	Chopra and Kadekodi (1997)
Iron ore	User cost per tonne: Rs. 8.63 per tonne	Goa	User cost method	TERI (2000), NBSAP

Box 6: Valuing eco-tourism in a sacred lake of the Sikkim Himalaya, India

Sacred lakes of the Himalayan region attract visitors and pilgrims from all over the world for their aesthetic, cultural and spiritual importance, The Sikkim Himalaya has more than 150 lakes at different altitudes and most are considered sacred. The recreational biodiversity and sacredness values of Khecheopalri, a lake

situated in the west district of Sikkim State, India is presented here.

Visitor numbers began to increase in Sikkim in 1990 as a result of a relaxation of regulations that opened a number of new areas to both domestic and foreign tourists. Until 1980, the state hosted only 15454 visitors, but this had increased five-fold by 1990, and reached 143410 in 1998. The number of visitors to Khecheopalri lake has grown rapidly from 16068 in 1997 to 18713 in 1998. In 1998, 7800 visitors arrived at the lake from Sikkim as pilgrims. About 78% of the pilgrims visited the lake for religious purposes, while the majority (85%) of the domestic visitors came for recreation. Most (65%) of the foreign visitors came to the lake for recreation, but 19% came for religious purposes and 16% cited the rich biodiversity of the area as their purpose in visiting. Approximately 56% of foreign visitors, 43% domestic visitors, 35% of local community members and 28% of pilgrims showed some interest in conservation and maintenance of the lake and its surrounding watersheds.

The salient features of the study are:

- A sample survey of 360 visitors, consisting of 50 members of the local community, 140 pilgrims, 95 domestic and 75 foreign visitors was carried out.
- Only 180 respondents (20 community members, followed by 34 domestic, 51 foreign visitors and 75 pilgrims) showed their willingness-to-pay (WTP) for conservation and protection of the lake, while others refused to participate.
- Method of collecting information: (a) a structured questionnaire, (b) random sampling at different times of day and during all days for one week, (c) only adult visitors, who had a defined source of income, were interviewed
- Data collected per visitor are: travel cost, number of visits per year, distance travelled from the origin of stay, income, age, sex, education and density
- Regression model of visitation rate with travel cost and distance was estimated.
- The travel cost for local pilgrims was positively related to visitation rate. TC model was used to calculate the consumer surplus. The estimated consumer surplus for visits to Khecheopalri lake was US$ 661 and US$ 1562 from the first and second consumer surplus, respectively. Recreational/sacredness value per visitor was US$ 3.87 as calculated from the consumer surplus.
- The total number of local pilgrims to Khecheopalri lake was 7800 in 1998, the aggregate annual recreational/sacredness value amounted to US$ 430186 for pilgrims. The higher cost of travel and distance of the lake from various zones of Sikkim restricted the visitation rate by pilgrims.

Application of the TCM and CVM strongly supports conservation of biodiversity destination and sacredness-related pilgrimage. There are a large number of similar lakes in the Hindu-Kush Himalayan region which might bring economic

benefits with simultaneously conservation links if they are properly managed and marketed.

Summary based on:

Maharana, I, S.C. Rai and E. Sharma (2000) Valuing ecotourism in a sacred lake of the Sikkim Himalaya, India. *Environmental Conservation* 27(3): 269-277.

Table 3: Natural Resource Accounting for Himachal Pradesh

Forest Resource contribution vs. Investment	
1. Value of Growing Stock	Rs. 40860 Crore
2. Total Economic Value of Forests	Rs. 106664 Crore
3. Total Expenditure incurred in forest (Annual Budget)	Rs. 109 Crore
4. Revenue realised by forests	Rs. 41 Crore
II. Contribution of Forests to the GSDP	
1. Total GSDP	Rs.9258 Crores
2. Forestry as logging	Rs. 487 Crores
3. Forestry as % of GSDP	Rs. 5.26 %
4. TEV of forests of HP (as per current estimation)	Rs. 106664 Crores
5. Corrected GSDP	Rs.115434 Crores
6. Forestry as % of corrected GSDP	92.40%

Note: GSDP= Gross state domestic product

Table 4:Production and Export of marine products of India (quantity in tones)

Products	**1992**		**1995**		**1999**	
	Production (Tons)	**% age of Exports in total landings**	**Production (Tons)**	**% age of Exports** in total landings	**Production (Tons)**	**% age of Exports** in total landings
Shrimp	**278191**	**27.42**	**253142**	**39.88**	**320023**	**31.64**
Lobster	**2011**	**81.15**	**1923**	**65.05**	**2093**	68.22
Fish	**1830271**	**2.71**	**1790063**	7.14	**1925569**	6.33
Crabs	**26940**	**4.34**	**30610**	9.14	**27547**	12.89
Molluscs	**89493**	**44.96**	**116764**	58.98	**93374**	74.81

Others	50102	4.03	66381	8.39	41897	10.05
Total	2299594	7.47	2258883	13.61	2417503	12.53

Table 5: Revenues Obtained from Non-Wood Forest Produce
(in Rs. '000)

States	Bamboo & Cane	Fodder & Grass	Gums & Resins	Drug & Spices	Tannin & Dyes	Others	Total
Andhra Pradesh	34,976					54,213	89,189
Arunachal Pradesh	729					1,896	2,625
Assam	1880	59		3		12311	14,253
Bihar	13033	433	60			73203	86,729
Gujarat	3509	4607	269	1	43	1728	86,729
Haryana	232	516	567			279	1,594
Himachal Pradesh	485	1,601	22,938	2,342		28	27,394
J&K	640		180,000			21,050	201,690
Karnataka	20,427	385	24	425	1,078	61,510	83,849
Kerala						5,904	5,904
Madhya.. Pradesh	92,200					350,800	443,000
Maharashtra	10,979	3,885	2,866	16 7	895	42,840	61,488
Manipur	46					872	918
Meghalaya	32	Below 500	44	50		1,031	1,157
Nagaland	4					1,316	1,320
Punjab	101	3,477	649			1,269	5,496
Rajastha	14,574	892	2,583		137	23,319	41,505

n							
Sikkim	5	20		391		2,197	2,613
Tamil Nadu	1,721	1,337			8,147	60,218	71,423
Tripura	483	152				1093	1728
Uttar Pradesh	4904	6829	50252		200	53826	116011
West Bengal							3417
A& N	282		57			1087	1426
Goa, Daman & Diu	80						80
MIzoram	19					57	76

[The category `Others' includes fibres and flosses, vegetable oils and oilseeds, bidi leaves and other non-wood produce].

(Source - Central Statistical Organisation, 1990: 69)

4.2.5 Scientific values

It is well known that nature is the source, inspiration and basis of all scientific thought, since sciences in all cultures are centrally concerned with the understanding of nature. This biodiversity which constitute the whole of "living" nature has a profound and intrinsic scientific value. Although biological sciences in western and non western cultures have yet to discover and gain a fuller understanding of the vast diversity of species, their intra-specific variations,, their habitats and the complex web of inter-relationships, the specificities and complexities associated with biodiversity, that are thus far known, are indeed a source of inspiration and offer further challenges to scientists to know more.

Today the scientific values of bio-diversity are also influencing developments at the frontiers of seemingly unrelated fields like "Information Technology" in the context of subjects like artificial intelligence. Along side fascinating discoveries there are also a

number of new scientific controversies related to biosafety being raised in fields like genetics and biotechnology.

4.2.6 Cultural values

In the Indian languages, the two key words which point to the central relationship between nature and cultures are the words "Pra-kruti and Sams-kriti". Whereas nature (Prakriti) is seen as an unmodified (pra) life process (kriti), culture (samskriti) is described as the modified (samskar) process (kriti). There is a great deal of anthropological literature showing how interaction with, use of, and observation of diversity of life forms and ecosystems has been the source of all cultural evolution and technological innovation (McNeely, 1992). It would be safe to assert that the incredible extent of human creativity manifested throughout history is founded on the ecosystems diversity found on earth.

The cultural values in human societies are often expressed in the form of respect for symbols of biodiversity. Some species such as the bald eagle are key icons of cultural heritages, while others – for example tiger, lion, lizard, turtles and bison- are integral to religious and spiritual beliefs. In local cultures the behaviour of several species is indicative of various material and non material events.In the Thakur tribal community of coastal Maharashtra the sighting of red ants before monsoon indicate an early onset of rains (R P Palekar, Personal Communication, 1998). The repeated chattering of a house lizard is a sign of the presence of lord Shiva. Species inspire songs, stories, dances, poetry, myths, crafts, regional cuisines, decorations, rituals, festivals, holidays and even names of sports teams.

Box 5: Religious, Spiritual, and Other Cultural Uses of Biodiversity

A great diversity of plants and animals have been used for purposes which are outside the sphere of basic subsistence needs of food, shelter, and clothing, but are yet consider to be equally important.

Rituals in all parts of India are occasions for the use of many plants and animals. Among auspicious plants and flowers offered in temples are Hibiscus offered to the goddess Kali, Datura flowers to Siva and flowers of Euphorbia ligularia to Manasa. Bel Aegle marmelos leaves are offered to Siva in ritual, green bamboos are considered sacred, and mango tree parts are used in sacrificial rites; the palas or dhak wood (Butea monosperma) is used to produce the sacrificial fire. Sandalwood and banana are considered sacred, and used in ceremonies during auspicious occasions like marriage. Kusa grass (Eragrostis cynasuroides) is necessary for most religious ceremonies. In Gujarat, sami (Prosopis cineraria) twigs are used in sacrificial fires (Desai, 1965).

Similarly, rice and til (Sesamum orientale) are used as offerings in religious ceremonies. Almost as if in celebration of diversity, the Visnu Purana enjoins the offering of 14 kinds of grain in ceremonies, among which are rice, barley, kidney bean, wheat, millet, seasamum, Macrotyloma uniflorum, a wild rice called nivara (possibly Oryza nivara), wild Sesamum called jarttila, coix and a wild panicum called markata (Wilson 1979 [1840]). Certain types of rice (called sawa and khaia) are grown specifically for use on religious occasions (Paroda & Joshi,1990: 277). In the Himalayan region of Jammu, Chenopods also have a religious significance among the Hindu Dogras. The grain is considered sacred and permissible to eat on days of fast, along with amaranths and buckwheat (Partap, 1990: 172). The odorous roots of Dolomiaea macrocephala (dhup) are used as incense and its flowers offered at shrines. In Ladakh, twigs of Juniperus communis are used as incense; other plant species used as incense are Potentilla argyrophylla and Waldheimia tomentosa (Buth & Navchoo, 1989).

The sacred nature of various plant and animal species has evolved on account of their association with different deities. Some animal species are termed as vahanas or vehicles of deities and are hence venerated. Important among these are the bull for Siva, the rat for Ganesa and the lion for Durga

Other ritual and sacred values are attached to plant/animal species. Mallotus phillipensis is used as a sindhur or kumkum by women to signify their marital status (CSIR, 1962). In Ladakh, the roots of Arnebia guttata yield a red dye which is used to decorate Buddha idols. Charms and sacred songs are written on the outer bark of the Betula utilis tree (Dastur, 1964: 35). Certain plants are grown so as to keep spirits away, such as the bamboo Dendrocalamus strictus (Nair, 1993), Descurainia sophia in Ladakh (Buth & Navchoo, 1989) and coconuts in the Nicobar Islands (Dagar & Dagar, 1986). The sacred chank Xancus pyrum is utilized to make bangles which are a sign of matrimony for women in Bengal. Among the Hos of Singhbhum, Bihar, parts of the sal Shorea robusta tree are used on occasions when religious rites are performed. Offerings of food and rice beer are made on leaves of the giant climber Bauhinia vahlii (Deeney & Fernandes, 1992: 57-58).

4.2.7. Ethical value

Each species is unique and has a right to exist. It has distinct qualities (Guna) and it has a definite role (Karma) to play in the ecosystem. Each species thus has intrinsic value and is worthy of respect regardless of its worth to human beings. It is this understanding and appreciation of the inherent value of each and every life form, that constitutes the "ethical" value of biodiversity.

4.2.8. Aesthetic Value

The vast diversity species and ecosystem adds to the richness and beauty of life on Earth. Once a species becomes extinct, it is gone forever. A natural ecosystem once destroyed is impossible to recreate.

Growing up in degraded environments, alien to Nature, can result in the implantation of negative attitudes in human populations. A study of the impact of environment on the psyche was undertaken by Kaplan and Kaplan (1989), in which they found that being near nature relieved working stresses, while people who worked in closed environments or with views of only human-made structures experienced much more job stresses and illnesses.

The value people put to the aesthetic function of nature is partly reflected in the amount of tourism to areas of natural beauty. <<<Overall data on tourism to be added>>>. In a survey of 101 national parks and sanctuaries conducted in 1983-84, tourist traffic was found to be over 50,000 annually in nine (Kothari et al. 1989). In a majority of these protected areas, it seemed that tourism was low due either to their being unknown to all but the most avid of wildlife lovers, or because of a complete absence of facilities for tourists. The function of a natural area near or within a dense human settlement is clearly seen in the case of the Sanjay National Park on the outskirts of Mumbai, which receives a colossal traffic of 15 lakh (1.5 million) tourists every year!

AK
Pl discuss
SP
[From 4.2.4]

DS/NBSAP...corres/2002

4/4/2002

Dear Ashish,

NBSAP document

Enclosed is the whole document on chapter 4.2 with sub sections upto 4.2.7.

I have scanned the data from different NBSAP documents of which I do not have electronic copies. I think, electronic form is available with your office.

Please acknowledge receipt.

Regards,

Darshan Shankar

PS: There are some boxes pertaining to 4.2.4 which I have taken from different NBSAP documents. I have scanned them since I don't have soft copies. I will send the 'boxes' by post. You will have soft copies of the original sources.

4.2 Importance and uses of bio-diversity in India

4.2.1 Ecosystem services and values of bio-diversity

There is growing public awareness about the importance of maintaining a high level of bio-diversity in the context of what is referred to as "eco-system services".

Imp. to focus on natural ecosystems or diverse agro-ecosys. | This is re. biodiv. values, not simply natural ecs. values

Ecosystem services in a strict sense are all the services generated as a result of interaction and exchange between biotic and abiotic components of ecosystems. The ecosystem services include numerous invisible but essential services, viz., soil formation and fertility generation, reduction of soil salinity, decomposition and waste dissipation, productivity, carbon sequestration and atmospheric gases balance, stabilization of climate and mitigation of climatic change, nutrient cycling, maintenance and raising of water table, water and air filtration, flood and drought control, etc.

Some examples of this would be useful

A balanced approach to bio-diversity should be based on the understanding that people of every region depend on the daily flow of local ecosystem services for managing their living, therefore there is a need to value and conserve the natural ecosystems of all regions and not only focus on hot-spots or flag-ship species. Identification and recognition of ecosystem services is therefore required at various scales from local to regional, national and global levels. Unfortunately, almost nothing has been done in India in regard to developing conservation approaches that have evaluated & considered ecosystem services in an integrated and systematic way.

Box on water security, esp. due to hills & wetlands

From the way we manage the forest and river systems to the way we deal with the coastal and agro bio-diversity, there is serious neglect of eco-systems. A major inter-regional exercise was initiated in the recent past on the restoration of Ganga River, but the approach was highly sectorial, as it did not lay focus on watershed connections. Cultural eutrophication of the lakes of Kashmir, Nainital and other such water bodies and loss of their recreational value, receding glaciers and depleted water flow to rivers severe pollution and degradation of major river systems, increase in the intensity of flood peaks, landslide and erosion in mountains, widespread gulley formation in Chambal ravines, fragmentation of forests and loss of forest cover, conversion of oak forests into pine forests in Himalaya, poor regeneration of sal and oak, degradation of mangroves, coral reefs and coastal life, salinisation, depletion of groundwater, metal toxicity in water, widespread expansion of exotic invasive species in natural ecosystems both terrestrial and aquatic, shortage of drinking water, spread of water borne diseases, degradation of recharge zones and drying-up of springs, almost complete extermination of vulture and lion, spread of slums, prolonged duration of winter fog, severe air pollution, loss of breeding habitats of turtles, conversion of swamps and other wetlands into agricultural land, shortening of rotation in shifting agriculture and consequent depletion of soil and fertility are some of the examples to indicate how impacted are our ecosystems and flow of their services.

Give some specific examples of impacts due to loss of ecosyst. services
- Soil loss due to deforestatn equal to fertiliser produ.?
- Coastal erosion due to loss of coral reefs & mangroves
- Floods/droughts in peninsular India (as reported by villagers — their perceptions?)
- Loss of soil quality & cover in monoculture farming

needs to be explained

Comparison of the ecosystem services of three Himalayan forests types

Forest type	Ecosystem characters	Ecosystem services
Banj oak (*Quercus leucotrichophora*)	Large biomass (400-500 t ha^{-1}); deep roots and deep carbon storage in soil; high amount of investment of photosynthesis in ectomycorrhizae, massive annual return of nutrients to soil.	Rapid soil formation, high soil fertility, effective carbon sequestration; effective nutrient and water retention.
Chir pine (*Pinus roxburghii*)	Small biomass (200-250 t ha^{-1}); high productivity on degraded slopes, high nutrient use efficiency; high stress tolerance, effective coloniser.	Supply of ecosystem services in inhospitable conditions; retention of nutrients on steep and rocky slopes; moderate nitrogen enrichment (?)
Alder (*Alnus nepalensis*)	Very small biomass (<100-150 t ha^{-1}), very high productivity (up to 30 t ha^{-1} yr^{-1}); rapid coloniser of fresh landslip; very high rate of N-fixation (up to 200 kg N ha^{-1} yr^{-1}).	Facilitation of more useful species, high carbon fixation, nutrient supply to other ecosystems.
Lantana camara (an invasive species)	Very small biomass (<30 t ha^{-1}), productivity similar to oak and pine; carbon shortage in shallow soils, low biodiversity, cool but frequent fires.	Low soil carbon storage, persistent fire regime, low nutrient and water retention.

Source : SP Singh's paper

When No.1 is changed to No.2, what is loss of ecosyst. services? (ask S.P. Sir ?)

Widespread villager observations of water springs drying up, more fire, etc.

Ecosystem Service from Western Himalaya

Mountains are regarded as the water towers of the world. The extraordinarily massive Himalayan Mountains have shaped the climate of the Indian subcontinent apart from providing water and soil to the Gangetic plains. Among the contribution of Himalaya are the monsoon pattern of rain, high round the year humidity, mild winters and slow lapse rate of temperature with increasing altitude. These influences are reflected in high biodiversity, forest cover up to considerable altitude, dominance of evergreen forest, rapid soil formation, and agriculture round the year.

The ecosystem services of the Western Himalayan forests to the people in the Gangetic plains are listed as following:

1. Rapid soil formation, particularly in oak forests, thus nursing crop-fields both in hills and plain by providing soil and nutrients.
2. Controlling flood peaks and erosion.
3. Maintaining water flow in rivers which contributes to pollution control and help maintain aquatic diversity and soil water storage.
4. Maintaining native crop diversity through human efforts, thus allowing evolution to take place.
5. Organically produced food (through human efforts, utilising forest services).
6. Carbon sequestration and climate stabilization.
7. Forest services of local use are:
   a. Formation of fertile soil utilised in crop-fields.
   b. Retention of water as spring water which is the only water source in most areas.
   c. Water filtration that serves to keep the lake water clean.
   d. Organically produced food.
   e. Restoration of landslide sites through the process of succession in which N_2 fixer woody species like alder (*Alnus nepalensis*) and coriaria (a bush) play important facilitating role. *In fact, succession is a composite ecosystem service generating soil, nutrients and control over all destabilising physical forces of nature.*

Source : S.P. Singh's paper

How is this a service of forests?

Some of these are repetitions of 1-6 above

In

4.2.2 Livelihoods

Particularly in a largely tropical country like India with a range of terrestrial and aquatic landscapes biodiversity supports livelihoods of millions of eco-system people. There is a population of around ..... million which resides around forests, wetlands and marine habitats and is dependent on the local eco-systems for their basic subsistence requirements with regard to water, food, fuel, housing, fodder and medicine. Around 10,000 species of plants, a few hundred of fish and animal species are involved in this relationship.

Table 3.9: Livelihood Linkages with Common Property Resources

No. of Districts and villages by state	Household by income categories[b]	Fuel[c] (%)	Animal grazing	Employment[e] Days	Annual income[f] (Rs)	% income From CPRs	Gini coefficient on income from[g] All sources	Gini coefficient on income from[g] All sources except CPRs(%)
Andhra	Poor	84	-	139	534	17	0.41	0.50
Pradesh (1,2)	Others	13	-	35	62	1	0.41	0.50
Gujarat (2.4)	Poor	66	82	196	774	18	0.33	0.45
	Others	8	14	80	185	1	0.33	0.45
Karnataka	Poor	-	83	185	649	20	-	-
(1,2)	Others	-	29	34	170	3	-	-
Madhya	Poor	74	79	183	733	22	0.34	0.44
Pradesh (2,4)	Others	32	34	52	386	2	0.34	0.44
Maharashtra	Poor	75	69	128	557	14	0.40	0.48
(3,6)	Others	12	27	43	177	1	0.40	0.48
Rajasthan	Poor	71	84	165	770	23	-	-
(2,4)	Others	23	38	61	413	2	-	-
Tamil Nadu	Poor	-	-	137	738	22	-	-
(1,2)	Others	-	-	31	164	2	-	-

Source: Jodha 1986

a. CPRs include community pasture, village forests, waste land, watershed drainage, river and stream banks, and other common lands. Data indicate average area per village.

b. The number of sample households from each village varied from 20 to 36 in different districts. "Poor" house-Holds are defined as agricultural laborers and small farmers (< 2 ha dry land equivalent). "Others" includes large Farm households only.

c. Fuel gathered from CPRs as proportion of total fuel used during three seasons covering the whole year.

d. Grazing days per animal unit on CPRs as a percentage of total grazing days per animal unit.

e. Total employment from CPR product collection.

f. Income derived mainly from CPR product collection. The estimation procedure underestimated the actual Income derived form CPRs.

g. A higher Gini coefficient indicates a higher degree of income inequalities. Calculations are based on income

Apart from this livelihood dependency for subsistence needs, there is livelihood dependency for seasonal or annual income derived from on a wide range of terrestrial and aquatic wild resources. There are estimated to be around 20 million mandays per

year involved in medicinal herb collection from the wild for a collection valued at around 112 crores per year.

According to the World Resources Institute (1990),nearly 500 million people in India depend upon on non-timber forest products(NTFP) for their livelihood. NTFP collection generates about 1063 million human-days of employment in India (Khare, 1989), at the nation scale, about 50% of income of about 20-30% of rural population comes from NTFPs .

Seems too high — pl recheck

There are estimated to be …… fisher-folk who depend on aquatic habitats for their livelihood.

The number of pastoralists and their livestock is of the order of ……. & …….

The small and marginal farmers who account for over 80% of the farming community in India constitute a population of ……..

The extent of livelihood dependency on biological resources and their host eco-systems is thus very substantial and there is an enormous challenge in a BSAP to suggest ways to make this dependence sustainable and equitable?

Sounds as it's desirable but not possible!

The option of completely alienating the so called eco-system people from their traditionally used resources is not available. Eco-system specific solutions, therefore, need to be found to match the imperatives of ecological sustainability with livelihood security.

and food security?

4.2.3 Health values

It is a curious fact but empirical evidence reveals that the largest use by communities of eco-system resources (8000 species of plants and a few hundred species of animals) is

for maintaining "health security" of human, livestock and plants(bio-pesticides and fertilizers).

Medicinal Plants Species Diversity & Representative Species of Biogeographic zones of India

Sr. No.	Biogeographic region	Estimated number of medicinal plants	Examples of some typical medicinal species
1	Trans Himalayan	700	*Ephedra gerardiana* Wall., *Hippophae rhamnoides* L., *Arnebia euchroma* (Royle) John
2	Himalayan	2500	*Aconitum heterophyllum* Wall. Ex Royle, *Ferula jaeschkeana* Vatke and *Saussurea costus* (Balc.) Lipsd. *Nardostachys grandiflora* DC., *Taxus wallichiana* Zucc., *Rhododendron anthopogon* D.Don and *Panax pseudoginseng* Wall.
3	Desert	500	*Convolvulus microphyllus* Seib ex Spreng (Syn *C. pluricaulis* Chois), *Tecomella undulata* (Sm.) Seem, *Citrullus colocynthis* (L.) Schrader and *Cressa cretica* L.
4	Semi-Arid	1,000	*Commiphora wightii* (A.) Bhandari, *Caesalpinia bonduc* (L.) Roxb., *Balanites aegyptiaca* (L.) Delile *and Tribulus rajasthanensis* Bhandari & Sharma.
5	Western Ghats	2000	*Myristica malabarica* Lam., *Garcinia indica* (Dup.) Choisy, *Utleria salicifolia* Bedd. and *Vateria indica* L.
6	Deccan Peninsula	3000	*Pterocarpus santalinus* L.f., *Decalepis hamiltonii* Wight & Arn., *Terminalia pallida* Brandis and *Shorea tumbuggaia* Roxb. *Pterocarpus santalinus* L.f
7	Gangetic Plain	1000	*Holarrhena pubescens* (Buch-Ham.) Wallich ex DC., *Mallotus philippensis* (Lam.) Muell.-Arg., *Pluchea lanceolata* C. B.Clarke and *Peganum harmala* L.
8	North-East India	2000	*Aquilaria malaccensis* Lam., *Smilax glabra* Roxb., *Ambroma augusta* (L.) L.f. and *Hydnocarpus kurzii* (King) Warb.
9	Islands	1000	*Calophyllum inophyllum* L., *Adenanthera pavonina* L., *Barringtonia asiatica* (L.) Kurz and *Aisandra butyracea* (Roxb.) Baehni.
10	Coasts	500	*Rhizophora mucronata* Lam., *Acanthus ilicifolius* L., *Avicennia marina* Vierh and *Sonneratia caseolaris* (L.) Engl.

Source: D.K. Ved , FRLHT Data

More complete ref. needed

The species used in health-care also include a vast diversity of eco-system specific food and fodder plants including species that are used by communities in times of scarcity. These plants contribute to the "food security" of the rural people.

With the development of modern high yielding varieties of crops and growing homogenization of food habits across the world an increasing reliance in market linked towns and cities has been placed on a few edible species. This was not always the case, nor is it still in many rural parts of the world. Approximately 80,000 edible plants have been used at one time or another in human history of which at least 3,000 have been used somewhat consistently (Ayensu 1983:22). However only about 150 have ever been cultivated on a large scale and a mere 10 to 20 provide 80 to 90% of the world's calories today(Soule, Carre and Jackson 1990)

A considerable part of daily food intake of rural (especially tribal) communities ~~costumes to be~~ from the wild. In an extensive study of wild foods by Singh and Arora(1978), information was collected from all over the country which revealed that a wide variety of tubers, edible grasses, flowers, fruits and seeds are eaten. Some examples are cited below:

Edible greens include leaves of Ardisa species and *Haliosma pinnata* from the north east; *Eremurus himalaicus* sedum species, *Origanum vulgare, Arenaria holosteoides* & *Urtica hyperborean* in Lahaul and Ladakh; in coastal areas, *Sesuvium portulacastrum* is eaten as spinach. Examples of edible seeds include those of *Nyphaea* and *Nelumbo* species, *Buchanania lanzen, Euryale ferox, Cleome icosandra* and *Alpinia galanga.*

Tribal populations in Madhya Pradesh, Andhra Pradesh and Santhal parganas of West Bengal (central and eastern India) use lichen species such as *Heterodermia tremulans. Everniastrum cirrhatum, Parmorrena reticulatum, P. ticnctorum, Ramalina subcomplanata, Usnes longissies, Rocella montagnei* as spice and flavouring agents (Singh & Sinha 1993. in press). In coastal areas of the southern state of Tamil Nadu, seaweeds such as Gracilaria edulis are used fro making gruel (Chennubhotia et.al., 1993, in press.

Some examples of floral species utilized primarily as famine foods, in Sikkim are the flowers of Urtica dioca and U. parviflora, rhizomes of Dioscorea species, fruits of *Aesandra butyracea, Calamus erectus, Eleagnus conferta, Heracleum lanatum, Podophyllum hexandrum, Machillus edulis, Melia dubia, Monus australis, Terminalia chebula*, *Zanthoxylum acanthopodium,* shots of Rheum nobile, Diplazium esculentum, Polygonum molle, Ficus vireus etc., Similarly, in the Rajasthan desert, famine foods include *Prosopis cineraria, Cenchrus biflorus,setigerus, Calligonus polygonoiges, Citrullus cologcynthis, s. lanatus. Dactyloctenium aegyptium, Acacia jacquemontii, A. leucophloes, Aizyphus nummularia, z. Mauritania, Indigofera cordifolia, Tamarindus indica, Capparis decidus, Salvadora oleoides, Achranthes aspera, Eleusine coracana, sesamum indicum and Cyperus rotundus.* It is also interesting that the desert locust (Schistocera gregaria) is relished both fresh and preserved. Chiefly stored and used during periods of scarcity. In the Bhimashankar wildlife sanctuary in Maharashtra , dried unripe fruits of *Bombax ceiba* are stored and eaten during food shortages; unripe and ripe fruit of *Jasmimum malabaricum* is also boiled, dried and stored as cereal for times of food scarcity. It appears that earlier each household would store 5-6 kgs of this species for periods of shortages(Borges & Rane 1992). The Padhars of Gujarat in western India dig tubers of *Scirpus kysoor* in times of famine (AICRPE 1989: 16). Grain amaranths were similarly used as reserve foods in the Himalayas (Joshi & Rana 1991).
Wild edible seeds are also used as famine foods. Examples are Indigogera glandulosa, I. Linifolia, and I. Cordifolia, out of whose flour bread is baked. Seeds of grasses such as Echinochloa, Panicum, Eleusine species are made into bread or roasted. Grains of Bambusa are cooked as rice. Grains of legumes – Vigna capensis, Phaseolus sublobatus are cooked as pulses (Singh & Arora 1978).

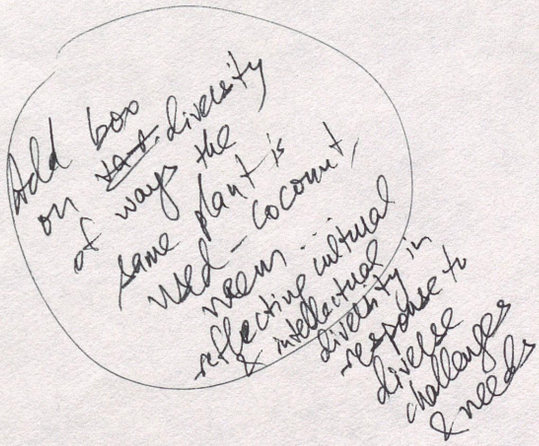
Health & food security value of agro-biodiv. also?

1. Several var. grown for medicinal value
2. Semi-wild in/around fields
3. Uncultivated foods in field, eg. aquatic creatures in rice field
4. Back-up varieties in times of calamity

Natural Insecticides

Several plant species are used for their insecticidal properties: Ipomea species are used against aphids and larvae of insect pests; Fagonia indica var. schweinfurthii for insects like blister beetle in bajra crop; castor for termite aphid; Calotropis gigantean for aphids; Leucas inticafolia and chillie for pests of storage; Euphorbia species for larvae

and pigeonpea; *Clerodendron multflorum* for aphids; Eleusine coracana for termites; Bidens biternata for insect pests of paddy (Gupta et al., n.d: Annexure 1). Recently, much emphasis is being placed on neem (Azadirachta indica) as a biopesticide. M. Krishnan has given an account of how jowar grains were stored for more than 30 years by being sealed in between layers of neem leaves in bins and buried in a 12 ft. deep pit (The Statesman, 22.3.92) Storing of wheat and barley grains with cowdung ashes was a practice to prevent insect attacks (Atkinson, 1973(1882). Besides the leaves, seeds and the oil from the seeds are used also as pesticides (Dastur, 1964: 30). The crushed fruit of Catunaregam spinosa ssp.spinosa is used to protect stored grains; the oil cake of Madhuca longifolia and the oil and leaves of Deris indica(=Pongamia pinnata) are used for their insecticidal properties (Dastur, 1964). Apart from neem, the oil from the seed of marking nut Terminalia bellerica is smeared and mixed with grain and is supposed to be the most effective protection from insects and pests. This is a practice in the Marathwada region of Maharashtra, where the tree is native (Darshan Shankar, pers. Comm.)



4.2.4 Economic Values

The economic value of eco-system services and components of bio-diversity, as estimated by constanza etal(1997) amounts to US $ 33 billion, which is around 1.8 times more than the world's GNP. Whereas these estimates give an overarching macro picture of the economic value of bio-diversity, it should be possible to disaggregate the overall economic values and form estimates of the worth of bio-diversity in the context of specific industries and sectors. However, serious research in this field has only been recently initiated and the methodologies for valuation are still being evolved. Therefore there is sketchy information on the economic values of bio-diversity. The inadequacy of economic data only reflects the limited efforts put into generating the data but this need not raise any doubt about the immense economic values of bio-diversity. Examples of the economic valuation of some bio-diversity components is given below by way of illustration.

Boxes on different valuation studies

Box 1

The pharmaceutical industry still depends to a great extent on wild resources estimated at around 1200 million rupees/year. Around 660 wild species are involved in all-India trade.

4.2.5 Scientific values

It is well known that nature is the source, inspiration and basis of all scientific thought, since all sciences are centrally concerned with the understanding of nature. Thus bio-diversity which is ~~a key subset of~~ nature has a profound and intrinsic scientific value. Although biological sciences in western and non western cultures have yet to discover and gain a fuller understanding of the vast diversity of species, their intra specific variations, , their habitats and the complex web of inter-relationships, the specificities and complexities associated with bio-diversity are indeed a source of inspiration and challenge to scientists in all cultures.

Today the scientific values of bio-diversity are also influencing developments at the frontiers of seemingly unrelated fields like "Information Technology" in the context of subjects like artificial intelligence. There are also a number of new scientific controversies being raised in fields like genetics.

4.2. .6 Cultural values

In ~~the~~ Indian languages, the two key words which point to the central relationship between nature and cultures are the words "Pra-kruti and Sams-kriti". Whereas nature is seen as an unmodified (pra) process (kriti), culture is the modified (samskar) kriti (process). There is a great deal of anthropological literature showing how interaction with, use of, and observation of diversity of life forms and ecosystems has been the source of all cultural evolution and technological innovation (McNeely, 1992). It would be safe to assert that the incredible extent of human creativity manifested throughout history is founded on the ecological diversity found on earth.

The cultural values in human societies are often expressed in the form of respect for symbols of bio-diversity. Some species such as the bald eagle are key icons of cultural heritages, while others – for example, turtles and bison- are integral to religious and spiritual beliefs. Species inspire songs, stories, dances, poetry, myths, crafts, regional cuisines, decorations, rituals, festivals, holidays and even names of sports teams.

Box on cultural Value of bio-diversity

427.

A great diversity of plants and animals have been used for purposes which ~~would seem to be~~ are outside the sphere of basic subsistence needs of food, shelter, and clothing, but are perhaps equally important. These include religious, spiritual, and other cultural uses.

Rituals in all parts of India are occasions for the use of many plants and animals. Among auspicious plants and flowers offered in temples are Hibiscus offered to the goddess Kali, Datura flowers to Siva and flowers of Euphorbia ligularia to Manasa. Bel Aegle marmelos leaves are offered to Siva in ritual, green bamboos are considered sacred, and mango tree parts are used in sacrificial rites; the palas or dhak wood (Butea monosperma) is used to produce the sacrificial fire. Sandalwood and banana are considered sacred, and used in ceremonies during auspicious occasions like marriage. Kusa grass (Eragrostis cynasuroides) is necessary for most religious ceremonies. In Gujarat, sami (Prosopis cineraria) twigs are used in sacrificial fires (Desai, 1965).

Similarly, rice and til (Sesamum orientale) are used as offerings in religious ceremonies. Almost as if in celebration of diversity, the Visnu Purana enjoins the offering of 14 kinds of grain in ceremonies, among which are rice, barley, kidney bean, wheat, millet, seasamum, Macrotyloma uniflorum, a wild rice called nivara (possibly Oryza nivara), wild Sesamum called jarttila, coix and a wild panicum called markata (Wilson 1979 [1840]). Certain types of rice (called sawa and khaia) are grown specifically for use on religious occasions (Paroda & Joshi,1990: 277). In the Himalayan region of Jammu, Chenopods also have a religious significance among the Hindu Dogras. The grain is considered sacred and permissible to eat on days of fast, along with amaranths and buckwheat (Partap, 1990: 172). The odorous roots of

Dolomiaea macrocephala (dhup) are used as incense and its flowers offered at shrines. In Ladakh, twigs of Juniperus communis are used as incense; other plant species used as incense are Potentilla argyrophylla and Waldheimia tomentosa (Buth & Navchoo, 1989).

The sacred nature of various plant and animal species has evolved on account of their association with different deities. Some animal species are termed as vahanas or vehicles of deities and are hence venerated. Important among these are the bull for Siva, the rat for Ganesa and the lion for Durga (see also Chapter 6 for the conservation value of these beliefs).

Other ritual and sacred values are attached to plant/animal species. Mallotus phillipensis is used as a sindhur or kumkum by women to signify their marital status (CSIR, 1962). In Ladakh, the roots of Arnebia guttata yield a red dye which is used to decorate Buddha idols. Charms and sacred songs are written on the outer bark of the Betula utilis tree (Dastur, 1964: 35). Certain plants are grown so as to keep spirits away, such as the bamboo Dendrocalamus strictus (Nair, 1993), Descurainia sophia in Ladakh (Buth & Navchoo, 1989) and coconuts in the Nicobar Islands (Dagar & Dagar, 1986). The sacred chank Xancus pyrum is utilized to make bangles which are a sign of matrimony for women in Bengal. Among the Hos of Singhbhum, Bihar, parts of the sal Shorea robusta tree are used on occasions when religious rites are performed. Offerings of food and rice beer are made on leaves of the giant climber Bauhinia vahlii (Deeney & Fernandes, 1992: 57-58).

But first?

4.2.7. Aesthetic value

Each species is unique and has a right to exist. Each species is worthy of respect regardless of its worth to human beings.

Separate ethical/intrinsic value— put 1st

The vast diversity species and ecosystem adds to the richness and beauty of life on Earth. Once a species becomes extinct, it is gone forever. A natural ecosystem once destroyed is impossible to recreate.

Growing up in degraded environments, alien to Nature, can result in the implantation of negative attitudes in human populations. A study of the impact of environment on the psyche was undertaken by Kaplan and Kaplan (1989), in which they found that being near nature relieved working stresses, while people who worked in closed environments or with views of only human-made structures experienced much more job stresses and illnesses.

The value people put to the aesthetic function of nature is partly reflected in the amount of tourism to areas of natural beauty<<<. Overall data on tourism to be added >>>. In a survey of 101 national parks and sanctuaries conducted in 1983-84, tourist traffic ~~was found to be~~ of over 50,000 annually ~~in nine~~ (Kothari et al. 1989). In a majority of ~~these~~ other protected areas, it seemed that tourism was low due either to their being unknown to all but the most avid of wildlife lovers, or because of a complete absence of facilities for tourists. The function of a natural area near or within a dense human settlement is clearly seen in the case of the Sanjay National Park, on the outskirts of Mumbai, which receives a colossal traffic of 15 lakh (1.5 million) tourists every year!

at least 9 were listed as having a

Box 4.2.4

Forests in Maharashtra	*Contribution of forests is estimated as Rs.35,245.65 millions as against Rs.14,080 millions shown in SNA. (i.e. it is 3.56 % of adjusted NSDP and not 1.46 % recorded) *Value of depletion (difference between the value of opening stock, other volume changes and the closing stock in forest accounts) = Rs.6.989 millions. (this is 19.8 % of the estimated value added) *Estimated asset values of forests = 28.6% of net fixed capital stock.	Maharashtra state	Physical accounting (tools employed: net price method, present value method, etc)	Parikh and Haripriya (1998)
Forests in Yamuna Basin	*Use Value of timber: Rs.8,279 to Rs.18,540 per cubic meter of extracted timber *Annual Value of main non-timber forest products (NTFPs): Rs.7509 per sq. km in Hills and Rs.558 per sq. km in Plains *Use value of ecological functions and unrecorded production: Rs.176 per hectare in Himachal Pradesh Rs.3509 per hectare in Haryana Average: Rs.624 per hectare *Value of preservation as contributing to national output: Rs.576lakhs per year *Household willingness to pay in rural areas for use value of forests: Rajasthan: Rs.1072 per hectare Uttar Pradesh: Rs.360 per hectare Himachal Pradesh: Rs.176 per hectare Haryana: Rs.3509 per hectare	Yamuna Basin	CVM Direct market valuation Multi-criteria analysis & Travel cost	Chopra and Kadekodi (1997)
Iron ore	User cost per tonne: Rs. 8.63 per tonne	Goa	User cost method	TERI (2000), NBSAP

Biodiv.?

Add some wetlands?

East Kolkata

BOX-2

Table 4.7: Economic value of the components of Natural Resources: Some Select Indian Studies ON ECO TOURISM

Goods and services valued	Annual Value	Location	Methodology applied	Source
Recreation/ Ecotourism	Rs.16197 per ha. (Rs.427.04 per Indian visitor Rs.432.04 per foreign visitor)	Keoladeo National Park, Bharatpur	Travel Cost Method	Chopra (1998)
Recreation/Ecotourism	Rs.20944 per ha. (Rs.519 per Indian visitor and Rs.495 per foreign visitor)	Keoladeo National Park	Contingent Valuation Method	Murthy& Menkhuas (1994)
Recreation/Ecotourism & other benefits	Rs.23300 per ha. (Rs.90 per household. (Rs.7.5/month/household);Rs.240 Million/year	Boriveli National Park, Mumbai	Contingent Valuation Method	Hadker et.al (1995)
Ecotourism	Rs.676 per ha . (for locals); (Rs3.2 million total per year)	Periyar Tiger Reserve	Contingent Valuation Method, Travel cost Method	Manoharan(1996)
Ecotourism	Rs 2.95 million total; (Rs.34.68 per visitor)	Kalakadu Mundanthurai Tiger Reserve, Tamil Nadu	Contingent Valuation Method	Manoharan and Dutt (1999)
Ecotourism/recreational/pilgrimage/sacred grove	WTP for maintenance and preservation of the lake by: Local community= US $ 0.88 (Rs.36.08) Local pilgrims = US$ 2.2 (Rs90.2) Resident visitors=US$ 2.5 (Rs102.5) Non-resident visitors=US$7.2 (Rs.295.2) (Aggregate WTP = US $46940 based on	Recreational value of a sacred lake in Sikkim Himalaya (Khecheopalri lake)	TCM & CVM	Maharana et.al.(2000)

Box 2 4.2.4

	total visits per year (Rs1.92 million) Per hectare value = Rs.1604			
Ecotourism	WTP for the management of the park: By foreign tourists: $8.84; by domestic tourists:$1.91; by local community:$6.20 per year. WTP total for annual maintenance works out to $87,777.	Khangchendzonga National Park, Sikkim	CVM	Maharana et al. 2000
Wetland	Additional value of property around the lake is Rs. 186 per sq. ft.	Bhoj Lake, Bhopal	Hedonic pricing	Madhu Verma (2000)
Soil conservation	Cost of soil erosion: Rs.21583 per hectare	Doon valley	Replacement cost approach	Kumar, P. (2000)
Soil conservation	Decline in Value of land due to soil degradation is Rs.3510 per hectare.	Haryana agricultural land	Productivity approach	Kirit Parikh (2001)
Urban water pollution	Av. Cost of illness per household per year: Rs. 1094	City of New Delhi	Production function	Dasgupta, P. (2001)
Biomass/dung/ watershed	Value of additional dung collected due to stall feeding is Rs.34.40 per cattle per year	Sukhomajri village	Opportunity cost	Chopra et al., 1990
Water supply	Rs.4745 per hectare	Almora Forests	Indirect Methods	Chaturvedi, 1993
Water supply	Annual willingness to pay for water: Rs. 109-410 for irrigation purposes; Rs.27-53 for drinking purposes	From glacier to Tarai mountain region of Kumaon valley	Contingent valuation method	Kadekodi, 2000
Ecological functions (use value) for local residents.	Rs.624 per hectare	Yamuna Basin	Contingent Valuation method	Chopra and Kadekodi, 1997
Carbon store	Rs. 1,292 billion for total Indian forests) & Rs.20125 per hectare	Indian Forests	Species wise forest inventory data	Haripriya (1999)
Carbon Store	Rs.1.2 lakh per hectare	All India forests	Biomass estimation	Kadekodi & Ravindranath (1997)
Urban Air pollution	Statistical value of life affected:Rs.2.87 lakhs per life; Human capital value affected: Rs. 3.83 per life	Mumbai city	Dose –response model	Jyoti Parikh (2000)
Water pollution	WTP for best quality: Rs. 500; for 1995 quality: Rs. 200; for 1985 quality; Rs. 100 (all these are median values)	River Ganga	CVM for non-user benefits	James and Murty, 1999
Water pollution	Economic cost of pollution abatement per kilo-litre wastewater per day in tanneries: Rs.20-66	Tanneries in Tamil Nadu	Cost-benefit model	U. Sankar (2000)
Fishery resources	Willingness to pay for conservation: Rs. 859 per year on average	Coastal Karnataka	Stakeholder Analysis and CVM	Bhatta (2000)
Watershed Values (Soil conservation)	Rs.2.0 lakh per hectare meter of soil	Yamuna Basin	Indirect method (Reduced cost of alternate technology)	Chopra & Kadekodi,1997
Forests in Himachal Pradesh	*The total economic value of forests in HP is estimated as Rs.106664 Crores, which is 2.61 times the value of the growing stock. * The contribution of forestry as a percentage of corrected GSDP is 92.40% instead of recorded 5.26%.	Himachal Pradesh State	TEV approach	Verma (2000)

Box 3

Table ???: Revenues Obtained from Non-Wood Forest Produce

(in Rs. '000)

States	Bamboos & canes	Fodder & grass	Gums & resins	Lac	Drugs & Spices	Tanning materials & dyestuffs	Others	Total
Andhra Pradesh	34,976	-	-	-	-	-	54,213	89,18
Arunachal Pradesh	729	-	-	-	-	-	1,896	2,62
Assam	1,880	59	-	-	3	-	12,311	14,25
Bihar	13,033	433	60	-	-	-	73,203	86,73
Gujarat	3,509	4,607	269	-	1	43	1,728	10,15
Haryana	232	516	567	-	-	-	279	1,59
Himachal Pradesh	485	1,601	22,938	-	2,342	-	28	27,39
J&K	640	-	180,000	-	-	-	21,050	201,69
Karnataka	20,427	385	24	-	425	1,078	61,510	83,84
Kerala	..	..	..	..	..	..	5,904	5,90
Madhya Pradesh	92,200	..	..	..	-	..	350,800	443,00
Maharashtra	10,979	3,885	2,866	16	7	895	42,840	61,
Manipur	46	-	-	-	-	-	872	91
Meghalaya	32	below Rs500	44	-	50	-	1,031	1,15
Nagaland	4	-	-	-	-	-	1,316	1,32
Orissa	21,092	783	410	31	3,764	322	61,929	88,33
Punjab	101	3,477	649	-	-	-	1,269	5,49
Rajasthan	14,574	892	2,583	-	-	137	23,319	41,50
Sikkim	5	20	-	-	391	-	2,197	2,61
Tamil Nadu	1,721	1,337	-	-	-	8,147	60,218	71,42
Tripura	483	152	-	-	-	-	1,093	1,72
Uttar Pradesh	4,904	6,829	50,252	-	200	-	53,826	116,01
West Bengal	..	..	..	..	..	..	..	3,42
A&N	282	-	57	-	-	-	1,087	1,42
Goa, Daman Diu	80	-	-	-	-	-	-	8
Mizoram	19	-	-	-	-	-	57	

[The category 'Others' includes fibres and flosses, vegetable oils and oilseeds, bidi leaves and other non-wood produce].

(Source - Central Statistical Organisation 1990: 69)

P.T.O

More recent est - should be avail.? (Ask Shanti Sharma) Also check Planning Commn figures?

Box 4

b. Agriculture, Livestock and Fisheries

The contribution of natural and agricultural biodiversity in terms of crops, livestock, and fisheries, is very substantial, and at least a part of this is expressed in commercial terms.

Mention Not clear if this is value of biodiversity as distinct from biol. resources

Box 4

Livestock also contributes significantly to India's economy. Cattle and buffalo are estimated to contribute nearly 15% of gross national income. The all-India value of goats (products such as meat, skin and hair) is calculated at about Rs. 13396 lakhs (1,339.6 million). The total annual value of poultry production is estimated to be Rs. 17550 lakhs (1,755 million), while pork and pork products contribute more than Rs. 150 million to the economy (PID 1990). The gross value of output from Animal Husbandry and Dairy Development sectors is estimated at Rs. 44,500 crore (445,000 million) in 1990-91 (Ministry of Finance 1992-93: 167).

In India, most fish spawn comes from the wild with less than 10% of fish spawn being produced artificially (Prescott-Allen & Prescott-Allen

Box 4

1983). However, the fisheries' sector is one which has noted much progress in monetary terms. Exports of marine products in 1992-92 are estimated at Rs. 1375 crore (Ministry of Finance 1992-93: 168). The most favoured species of India's sea catch are sardines (especially oil sardine), Indian mackarel and prawns (Jhingran 1991: 585).

Figures for 2000 should be available

Biol. resource value can be put into biodiv. value only in so far as its continued existence & functioning is dependent on biodiversity

Chemicals like prostaglandins, medically useful for birth control, prevention of peptic ulcer, asthama treatment, blood pressure regulation, etc., are obtained from marine species like gorgonids (Thomas & George 1993 in press). Biomedical properties are also present in sponges - the compounds Aerothionin and Aeraphysinin, halogen compounds like bromine and iodine; spongouroidine and spongothymidine have antitumour and antiviral activities respectively (Thomas 1993 in press). The blue-coloured blood of the horseshoe crab contains a chemical called "amoebocyte lysate" which is used to test the magnitude of adulteration of food and medicines (Indian Express 22.4.92; Probe India May 1992).

Microorganisms (fungi, actinomycetes and bacteria) are used to transform chemically synthesized steroid hormones in such a way so as to make them resemble naturally occurring hormones. These can be used clinically. Thus, antibiotics formed by fungi are penicillins from *Penicillum* species; Cephalosporins from *Cephalosporium* species; Griseofulvin from *P. griseofulvum*. Unicellular bacteria such as *Bacillus brevis, B. polymyxa, B. subtilis* produce the antibiotics Gramicidine, olymyxin B and Bacitracin respectively. Antibiotics formed by actinomycetes are Chloramphenicol from *Streptomyces venezuelae*, Tetracyclines from *S. rimosus* and *S. aureofaciens*; Neomycin from *S. fruidiae*, Erythromycin from *S. erythreus*, Nystatin from *S. noursei* and Amphotericin B from *S. nodusus*. (Guru 1990: 73-74).

Box-6

Table 3.5: Statewise Forest Revenue & Expenditure (1994-95 and 1995-96)

Get more recent stats

Rs. Lakhs

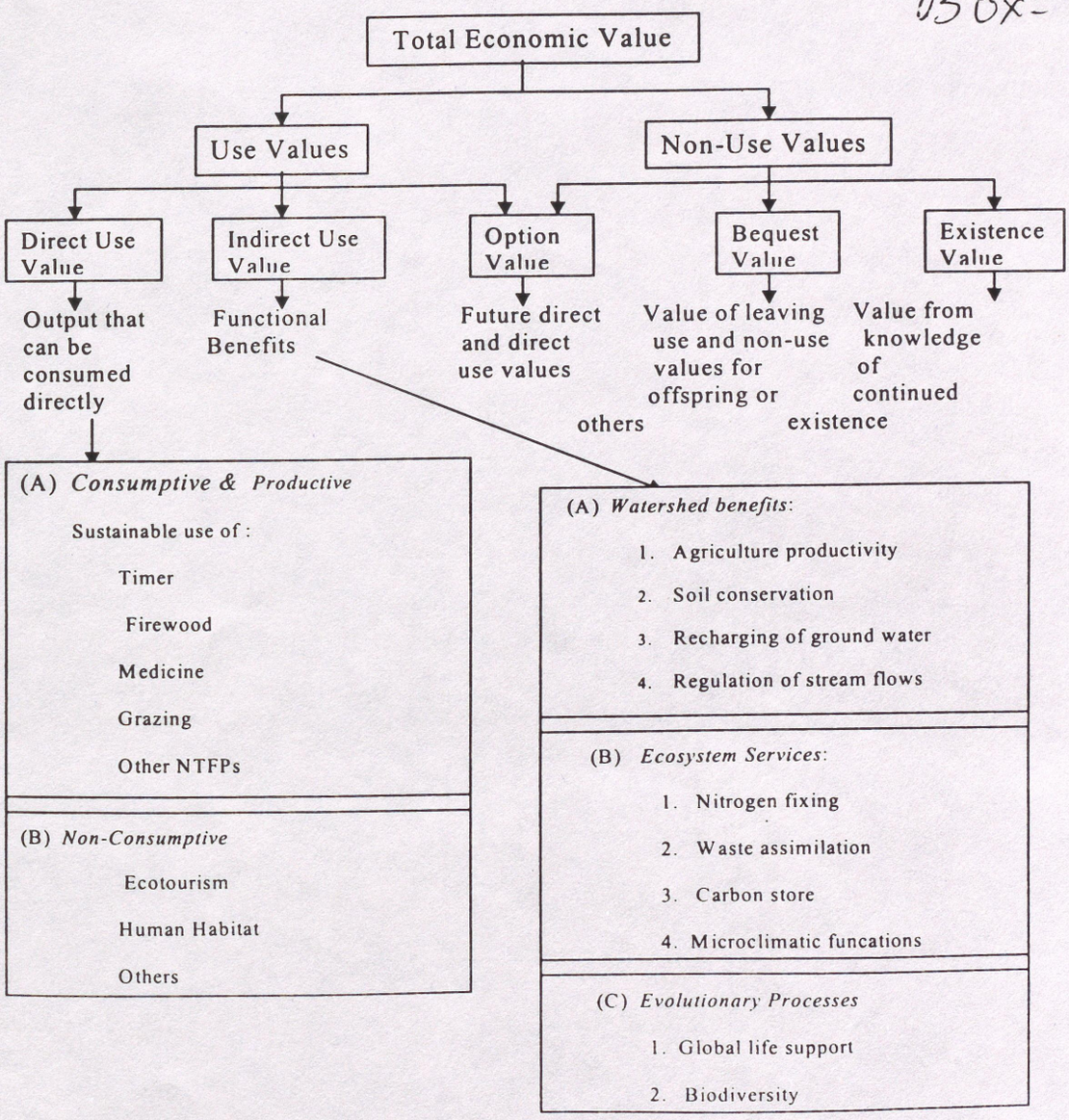
State/UT's	1994-95		1995-96	
	Revenue	Expenditure	Revenue	Expenditure
1	2	3	4	5
Andhra Pradesh	10285.35	6640.58	14405.26	8750.46
Arunachal Pradesh	3488.77	2095.35	4904.39	2416.67
Assam	1692.40	5212.27	1726.50	5467.83
Bihar	4615.61	4915.64	4721.00	NA
Delhi	0.06	13.86	0.06	30.29
Goa	138.87	300.44	138.82	293.22
Gujarat	2344.31	12007.09	2545.87	19850.77
Haryana	1442.31	4845.68	1956.68	5461.43
Himachal Pradesh	4711.00	8524.00	4494.00	9607.00
Jammu & Kashmir	1141.83	4861.00	3315.81	5945.42
Karnataka	9478.00	15047.10	10573.00	16515.90
Kerala	13688.49	6662.88	16076.54	7812.05
Madhya Pradesh	49936.00	36127.00	55716.60	40278.72
Maharashtra	14785.70	22402.61	13729.29	23165.27
Manipur	197.84	1136.18	223.48	1303.56
Meghalaya	450.77	499.87	514.64	639.23
Mizoram	1697.47	1741.29	1571.53	1570.90
Nagaland	220.75	482.21	275.10	997.83
Orissa	NA	NA	6807.43	5718.84
Punjab	525.05	1878.08	668.51	2147.33
Rajasthan	1337.63	3555.99	1317.67	3453.37
Sikkim	125.00	325.00	190.00	425.00
Tamilnadu	6481.00	8653.37	5796.59	9367.05
Tripura	290.04	502.16	303.82	652.96
Uttar Pradesh	7760.01	13161.55	9846.70	15219.32
West Bengal	4497.89	8630.93	4351.56	9128.95
A & N Islands	2984.72	2565.98	2815.68	2807.51
D & N Haveli	26.63	191.19	23.36	128.28
Chandigarh	8.04	111.77	18.61	185.03
Lakshadweep	---	---	---	---
Pondicherry	---	---	---	---
Total	**144153.64**	**173091.07**	**169028.44**	**199340.82**

Source: Forest Statistics of India, 1996

Box-7

Source ?

Total economic value of forests



Box-8

Box 4.7: Value of manure in terms of equivalent chemical fertilizer

Consider the situation of Sukhomajri, the famous watershed experiment carried in the early 80's in lower Shivaliks hills in Haryana state. Under an integrated watershed programme, the villagers of Sukhomajri (and later on many other villages) took to stall feeding the cattle, thereby reducing the pressure on forest slopes. This activity alone enabled them to collect dung at their door step, usable as manure for their crop cultivation. Stall-feeding has reversed the process of forest degradation. What is the value of stall-feeding then? It is evaluated in terms of the amount of chemical fertilizer saved in maintaining the crop agriculture. That is the value of the substitute for manure.

The computation follows as:

- The equivalence of manure per cattle per year is 30 kg of nitrogenous and 4 kg of phosphate fertilizer.
- As compared to the pre-watershed (and stall feeding) situation, the amount of dung collected has doubled (as per the survey in the villages).
- This is equivalent to 17 kg of fertilizer per year (15 kg of nitrogeneous+ 2 kg of phorsherous fertilizer), per animal per year.
- Going by the market price of fertilizer, the value of this fertilizer saved is Rs. 37.40

Summary based on :Chopra et al., 1990

Box-9

Box 4.14: Valuing eco-tourism in a sacred lake of the Sikkim Himalaya, India

Sacred lakes of the Himalayan region attract visitors and pilgrims from all over the world for their aesthetic, cultural and spiritual importance, The Sikkim Himalaya has more than 150 lakes at different altitudes and most are considered sacred. The recreational biodiversity and sacredness values of Khecheopalri, a lake situated in the west district of Sikkim State, India is presented here.

Visitor numbers began to increase in Sikkim in 1990 as a result of a relaxation of regulations that opened a number of new areas to both domestic and foreign tourists. Until 1980, the state hosted only 15454 visitors, but this had increased five-fold by 1990, and reached 143410 in 1998. The number of visitors to Khecheopalri lake has grown rapidly from 16068 in 1997 to 18713 in 1998. In 1998, 7800 visitors arrived at the lake from Sikkim as pilgrims. About 78% of the pilgrims visited the lake for religious purposes, while the majority (85%) of the domestic visitors came for recreation. Most (65%) of the foreign visitors came to the lake for recreation, but 19% came for religious purposes and 16% cited the rich biodiversity of the area as their purpose in visiting. Approximately 56% of foreign visitors, 43% domestic visitors, 35% of local community members and 28% of pilgrims showed some interest in conservation and maintenance of the lake and its surrounding watersheds.

The salient features of the study are:

- A sample survey of 360 visitors, consisting of 50 members of the local community, 140 pilgrims, 95 domestic and 75 foreign visitors was carried out.
- Only 180 respondents (20 community members, followed by 34 domestic, 51 foreign visitors and 75 pilgrims) showed their willingness-to-pay (WTP) for conservation and protection of the lake, while others refused to participate.
- Method of collecting information: (a) a structured questionnaire, (b) random sampling at different times of day and during all days for one week, (c) only adult visitors, who had a defined source of income, were interviewed
- Data collected per visitor are: travel cost, number of visits per year, distance

Box - 9

travelled from the origin of stay, income, age, sex, education and density

- Regression model of visitation rate with travel cost and distance was estimated.
- The travel cost (TC) for local pilgrims was positively related to visitation rate. TC model was used to calculate the consumer surplus. The estimated consumer surplus for visits to Khecheopalri lake was US$ 661 and US$ 1562 from the first and second consumer surplus, respectively. Recreational/sacredness value per visitor was US$ 3.87 as calculated from the consumer surplus.
- The total number of local pilgrims to Khecheopalri lake was 7800 in 1998, the aggregate annual recreational/sacredness value amounted to US$ 430186 for pilgrims. The higher cost of travel and distance of the lake from various zones of Sikkim restricted the visitation rate by pilgrims.

Application of the TCM and CVM strongly supports conservation of biodiversity destination and sacredness-related pilgrimage. There are a large number of similar lakes in the Hindu-Kush Himalayan region which might bring economic benefits with simultaneously conservation links if they are properly managed and marketed.

Summary based on:

Maharana, I, S.C. Rai and E. Sharma (2000) Valuing ecotourism in a sacred lake of the Sikkim Himalaya, India. *Environmental Conservation* 27(3): 269-277.

Has ecological/social impact of this level/kind of tourism been factored in? (as in Eklavya?)

Box-10

The value of the purification function of wetlands is significant: New York City recently found that it could avoid spending US $3-8 billion on new waste water treatment plants (with US$ 700 million annual operating costs) by investing just US$ 1.5 billion in buying land around the reservoirs upstate as well as instituting other protective measures to protect the watershed that will do the job of purifying the water supply for free.

Using this purification capacity of wetlands, Calcutta has pioneered a system of sewage disposal that is both efficient and environmentally friendly. Built to house one million people, Calcutta is now home to over 10 million, many living in slums and creating a sanitation nightmare. But the 8,000-hectare East Calcutta marshes, a patchwork of tree-fringed canals, vegetable plots, rice paddies and fish ponds, along with the assistance of 20,000 people, daily transform one third of the city's sewage and most of its domestic refuse into 20 tonnes of fish and 150 tonnes of vegetables. Mobilising people and wetlands here dispenses with the need for costly engineered sewage systems, brings great benefit to many local people, and solves at least part of the sanitation problem in the city.

Sources?

Used to be 20,000 ha. — mention its threats & that Mun. Corp. seems unaware of value

Box - 11

The mangrove is an amazingly versatile plant from a human perspective. Growing all over the world in tropical areas, the range of mangrove products used by humans includes thatch for roofing, fibres for textile and paper-making, timber for construction, fuelwood, medicines from bark, leaves and fruits, as well as dyes and tannins used to treat leather. In the Bangladesh portion of the Sundarbans, a 650,000-hectare mangrove forest spanning the border between India and Bangladesh, exploitation of the wetlands involves a 20-year mangrove cycle producing 45% of all the timber from state-owned forests and the sole source of newspaper print in the country. It employs 45,000 people during the peak harvesting season, and a further 10,000 fisherman live in the forest for 3-4 months each year exploiting the abundant fish.

Also as coast protection

Source?

Box 12

Table 5.5: Natural Resource Accounting for Himachal Pradesh

Forest Resource contribution vs. Investment	
1. Value of Growing Stock	Rs. 40860 Crore
2. Total Economic Value of Forests	Rs. 106664 Crore
3. Total Expenditure incurred in forest (Annual Budget)	Rs. 109 Crore
4. Revenue realised by forests	Rs. 41 Crore
II. Contribution of Forests to the GSDP	
1. Total GSDP	Rs.9258 Crores
2. Forestry as logging	Rs. 487 Crores
3. Forestry as % of GSDP	Rs. 5.26 %
4. TEV of forests of HP (as per current estimation)	Rs. 106664 Crores
5. Corrected GSDP	Rs.115434 Crores
6. Forestry as % of corrected GSDP	92.40%

Note: GSDP= Gross state domestic product

Source ?